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Original contribution

# Digital reporting of whole-slide images is safe and suitable for assessing organ quality in preimplantation renal biopsies☆

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**Summary** Digital pathology allows networks of "remote" specialist pathologists to report the findings of preimplantation kidney biopsies. We sought to validate the assessment of preimplantation kidney transplant biopsies for diagnostic purposes using whole-slide images according to the recommendations of the College of American Pathologists. Sixty-two consecutive, previously reported, preimplantation kidney biopsies were scanned using the ScanScope Digital Slide Scanner at 0.5 $\mu$m/pixel (20× objective). The slides were assessed for percent glomerulosclerosis, tubular atrophy, interstitial fibrosis and vascular narrowing using the Remuzzi criteria by two pathologists, one using glass slides and the other using the whole-slide images viewed on a widescreen computer monitor. After a 2-week washout period, all of the slides were re-assessed by the same pathologists using the opposite mode of reporting to that used in the first evaluation. Very high glass-digital intraobserver concordance was achieved for the overall score and for individual grades by both pathologists ($\kappa$ range, 0.841-0.973). The overall scores obtained by both pathologists and using both methods were identical. The times needed to assess the biopsies were 14 minutes when using a light microscope and 18 minutes, including scanning time, which averaged 2 minutes 20 seconds per slide, when using digital microscopy. Digital microscopy is a reliable, fast, and safe method for the assessment of preimplantation kidney biopsies.


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## 1. Introduction

Kidney transplantation is a therapy that has a good cost-benefit ratio, as it increases the survival and quality of life of patients with end-stage kidney disease. The imbalance between donor and recipient numbers for organ transplantation is increasing worldwide: in the United States, it is estimated that the number of patients with chronic kidney failure who would benefit from a transplant is growing at a yearly rate of 7% to 8%. The widening gap between the demand for and supply of transplant organs has prompted the expansion of the selection criteria for kidney donors [1,2]. In some countries or centers, biopsy assessment of the potential deceased donor kidney to determine its structural integrity and functional reserve plays a major role in determining which kidneys are suitable for transplantation [3,4]. In many centers in Europe, it has become routine to biopsy all kidneys over the age of 60 years to determine if they are suitable for transplant. The majority of donor recovery operations occur outside of normal working hours; thus, this practice of routine biopsy necessitates the use of an on-call histopathology service. In addition, pathological assessment of unexpected lesions found during the donor operation may be required to determine the suitability of the donor, mostly with regards to exclusion of cancer.

The increasing subspecialization of histopathologists makes having an on-call specialist histopathology service at all potential donor hospitals impractical and cost-prohibitive. The Royal College of Pathologists stated that pathologists should not be coerced into histological reporting outside of normal working hours of items that they do not report during their routine work [5]. The lack of a robust on-call service generates the risk of losing donor organs by increasing the chance of the donor becoming unstable due to delays in conducting the histopathology analysis while attempting to identify an available specialist pathologist and transporting the biopsy to that pathologist. In general, many units adopt a risk-averse policy in situations where information about the donor is lacking. Timely availability of histological information regarding the state of the organ and regarding uncertain lesions allows for a more informed decision-making process, resulting in more appropriate use of scarce organs [6].

Digital pathology transforms the diagnostic process through the creation of a whole-slide image (WSI) from a glass slide. This allows reporting pathologists to be geographically remote from the site of laboratory processing and scanning of the slides [7]. Several studies in recent years have demonstrated that primary histopathologic diagnoses can be rendered digitally using whole-slide imaging [8,9], and studies have shown the comparability and possibly superiority over microscopic assessment of the digital assessment of renal transplant biopsies using the Banff grading scheme [10,11], which is a similar semiquantitive system to the Remuzzi score for the assessment of potential donor kidneys. The College of American Pathologists recently published guidelines for the validation of whole-slide images for diagnostic use [12]:

1. All pathology laboratories implementing WSI technology for clinical diagnostic purposes should carry out their own validation studies. (Expert Consensus Opinion)

2. Validation should be appropriate for and applicable to the intended clinical use and clinical setting of the application in which WSI will be employed. Validation of WSI systems should involve specimen preparation types relevant to the intended use (eg, formalin-fixed paraffin-embedded tissue, frozen tissue, immunohistochemical stains, cytology slides, hematology blood smears). (Recommendation)

3. The validation study should closely emulate the real-world clinical environment in which the technology will be used. (Recommendation)

4. The validation study should encompass the entire WSI system. (Recommendation)

5. Revalidation is required whenever significant change is made to any component of the WSI system. (Expert Consensus Opinion)

6. A pathologist(s) adequately trained to use the WSI system must be involved in the validation process. (Recommendation)

7. The validation process should include a sample set of at least 60 cases for one application (eg, hematoxylin and eosin–stained sections of fixed tissue, frozen sections, cytology, hematology) that reflects the spectrum and complexity of specimen types and diagnoses likely to be encountered during routine practice. (Recommendation)

8. The validation study should establish diagnostic concordance between digital and glass slides for the same observer (ie, intraobserver variability). (Suggestion)

9. Digital and glass slides can be evaluated in random or nonrandom order (as to which is examined first and second) during the validation process. (Recommendation)

10. A washout period of at least 2 weeks should occur between viewing digital and glass slides. (Recommendation)

11. The validation process should confirm that all of the material present on a glass slide to be scanned is included in the digital image. (Expert Consensus Opinion)